Journals Pub

International Journal of
Environmental Noise and Pollution Control

ISSN: 2456-1614
Volume 1, Issue 1, 2023
DOI (Journal): 10.37591/IJENPC

https://journals.stmjournals.com/ijenpc

Review IJENPC

Environmental Advantages of Renewable Energy: A Review

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Abstract

There is a shortage of fuel in many emerging nations, including India, because of increased manufacturing for many different development initiatives. If the thermal energy sources used to meet this rise in demand are coal-based, environmental damage and high production costs ensue. So, the greatest alternative approach is for the nation to build renewable energy-based power facilities. Sustainable in light of current and future societal, economic, and social demands, renewable technologies are regarded as clean sources that minimise adverse environmental consequences and create the least secondary waste. The sun's rays, the most prevalent source of electricity, can be used directly or indirectly. There is a lot of potential to use the solar energy that is now accessible for temperature uses like cooking, water heating, and crop drying. A mature, competitive, and essentially pollution-free technology, wind energy is used extensively throughout much of the world to generate electricity. Additionally, the viability of gasification has been established, making it a potential technology. By displacing traditional energy sources, renewable energy technologies provide a great opportunity to reduce greenhouse gas emissions and halt global warming. It has been among the most successful models to produce clean, environmentally friendly, cost-effective energy and has numerous advantages. For the sake of long-term growth, this article discusses several types of renewable energy sources and their good and negative effects on the environment.

Keywords: Energy; Resources, Environment, Renewable, solar; Wind, Sustainable

INTRODUCTION

The tradable element related to technology involves energy. The impact of a 24-hour interruption in a city's electrical supply demonstrates how completely dependent we are on that particularly beneficial sort of energy. Without energy, society as we know it would collapse. However, in the current scenario, issues with electricity supply and consumption are linked not just to warming global temperatures yet additionally to issues with air pollution, acid rain, ozone depletion, deforestation, and toxic emissions. These factors must be taken into account if mankind is to have a bright energy future with minimal negative environmental effects. Increased reliance on renewable energy sources and technology is the answer to the looming energy crisis and the need for clean energy 14% of the worldwide overall need for energy is met by the usage of renewable energy (RES) [1]. The environment is impacted by all energy sources in some manner. By most measures, fossil fuels—coal, oil, and natural gas—cause much more harm than renewable energy sources, including air and water pollution, negative effects on human health, extinction of animal species and destruction of their habitats, excessive use of water and land, and global warming emissions. However, it is essential

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Received Date: August 11, 2023
Accepted Date: September 08, 2023
Published Date: December 1, 2023

Citation: Savita Chhipekar, Aniket Vishwkarma, Shyamkali Ahirwar, Nikhil Nagar. Environmental Advantages of Renewable Energy: A Review. International Journal of Power Electronics Controllers and Converters. 2023; 1(1): 31–39p.

to comprehend the environmental impacts of producing electricity from renewable sources such as wind, sun, geothermal, biomass, and hydropower. RES includes biomass, hydropower, geothermal, solar, wind, and marine energies. The primary, cleanest, and most abundant sources for power are renewable ones [2–3]. Large-scale hydropower generates 20% of the world's electricity. In windy locations like the coast, wind power is a viable energy source [1-4]. The percentage of RESs is predicted to rise. Also, it has recently come to light that renewable energy systems and sources can positively affect the following crucial global technological, environmental, economic, and political challenges [5]:

i. Serious environmental issues (e.g., acid rain, stratospheric ozone depletion, greenhouse effect) Environmental degradation
ii. Depletion of the world's nonrenewable energy sources
iii. Increasing energy use in developing countries.

RENEWABLE ENERGY RESOURCES

Future energy alternatives will be significantly influenced by alternative energy sources. Three types of energy resources have been established: nuclear, renewable, and fossil fuels [6]. Alternative forms of energy include solar energy, wind energy, biomass energy, geothermal energy, etc. that can be used repeatedly to produce energy(table1). Other forms of energy are another name for them [7-8].

Table 1. Sources used to produce energy scenario by 2040.

Energy sources	**2001**	**2010**	**2020**	**2030**	**2040**
Total Consumption (million tons oil equivalent)	10038	10549	11425	12352	13310
Biomass	1080	1313	1791	2483	3271
Large hydro	22.7	266	309	341	358
Geothermal	43.2	86	186	333	493
Small hydro	9.5	19	49	106	189
Wind	4.7	44	266	542	688
Solar Thermal	4.1	15	66	244	480
Photovoltaic	01	2	24	221	784
Solar termal electricity	0.1	0.4	3	16	68
Marine (tidal/wave/ocean)	0.05	0.1	0.4	3	20
Total RES	1365.5	1745.5	2964.4	4289	6351
Renewable energy source contribution (%)	13.6	16.6	23.6	34.7	47.7

SOLAR ENERGY

The energy generated by the sun is the radiant light and heat from the Sun that is captured and used to power a variety of constantly developing technologies, such as solar heating, solar architecture, solar thermal energy, and artificial photosynthesis [1]. The most practical and direct use of solar energy is in solar cooking. The potential for solar energy to rank among the top sources of energy for cooking is great [9–11]. There are many other varieties of solar cookers, but the box type solar cooker (Figure 1) is the most popular worldwide.

A household solar water heater that can meet every one of a family of four's hot water needs offers significant environmental protection and ought to be used wherever practical to ensure a sustainable future [12]. At 50% capacity utilization, it is projected that a household solar water heating system with a 100 l per day capacity can reduce CO2 emissions by approximately 1237 kg per year, and by approximately 1410.5 kg per year in hot and sunny regions [13]. The term "photovoltaics" (PV) refers to a process that uses semiconducting materials that exhibit the photovoltaic effect to transform solar energy into electrically powered power. A photovoltaic system employs solar panels made consisting of several solar cells that produce usable solar power. The technique is both mechanical and chemical in nature because the photoelectric effect, whereby occurs in the first stage, sets off a second electrolysis procedure during which crystalline atoms are ionized sequentially to produce a flow of electricity [2].

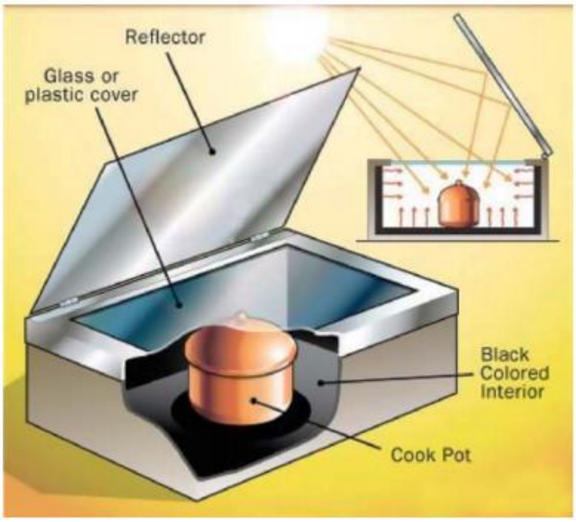

Figure 1. Solar-powered box cooker.

WIND ENERGY

Almost 3000 years have passed since the first recorded usage of wind power, and only approximately 120 years ago did mankind start using it to produce electricity. Oil prices have always influenced the growth of wind power. The technology of wind energy was first boosted during the 1970s oil crisis, but damped down afterwards [14]. Air movement across turbines that spin is utilized to dynamically power electrical generators. As a replacement for burning fossil fuels, wind energy is cheap, abundant, renewable, widely available, clean, emits no greenhouse gases while in use, and occupies minimal land. [15] Comparing the environmental impacts to those of nonrenewable power sources, the net effects are much less problematic.

Positive Impact of Wind Turbine

Wind turbines do not produce pollutants like others (coal, petroleum like fuels). It also helps in reducing pollutions by replacing to convention sources and the consequent reduce emission of carbon dioxide, nitrogen oxide and sulfur Dioxide. Due to a combination of greenhouse gas emissions, sea level rise, and unpredictable weather, these gases are to blame for acid rain and global warming. The utilization of one million kWh of wind power can prevent 600 million metric tons of CO_2 emissions, according to the international energy agency. [16]. Wind power is a feasible source of electricity in power-short developing nations because it can be erected and transported quickly, even in distant, difficult-to-reach, and steep areas[17]. The cost of producing power from the wind never rises or runs out. These systems' electrical output has the potential to prevent millions of tonnes of carbon and other emissions, as well as billions of barrels of oil [Thomas BG, Urquhart J]. Moreover, using wind energy helps prevent regional environmental issues brought on by coal burning [18].

Water is main source of energy in traditional power plants for the thermodynamic cycle's condensing phase. Water is also utilized in coal power plants to clean and treat the fuel. Millions of liters of water can be utilized each day. Water can be conserved and used for other things by using less of it.According to a research conducted by the Irish national grid, "Producing power generated by wind reduces the consumption and fossil fuels therefore leads to emissions savings" [19]. The study also calculated CO_2 emission reductions ranging from 0.33 to 0.59 tonnes per MWh.

To build a society that is truly sustainable, the environmental effects of wind turbines need to be properly researched and addressed. Some of the adverse environmental effects include damage on animals, impact noise, which includes mechanical noise made by moving parts such gear boxes, electrical generators, and bearings. Many variables, including as wear and tear, poor component designs, and a lack of preventative maintenance, might affect how much mechanical noise is normally produced [20]. Reduced blade tip speeds result in lower blade noise levels. Of particular importance is how wind turbine blades interact with air turbulence, which results in a characteristic "whooshing" sound [21].

BIOENERGY
Biogas
Biogas production through anaerobic decomposition possesses a number of advantages over other methods of producing bioenergy. It has been rated as one of the most ecologically friendly and energy-efficient technologies for bioenergy production [22]. Organic waste from homes and the food industry, crops grown specifically for energy, and agricultural waste products including crop leftovers and manure are some of the basic materials used [23].Nowadays, the animal breeding sector produces huge amounts of animal dung, Wet organic waste streams, and slurries that offer a persistent pollution concern and could have a negative influence on the environment if not managed properly (Figure 2). Closing the loops from production to use by using the best recycling practices is crucial to preventing emissions of greenhouse gases (GHG) and the leaching of nutrients and organic matter into the ecosystem [24].

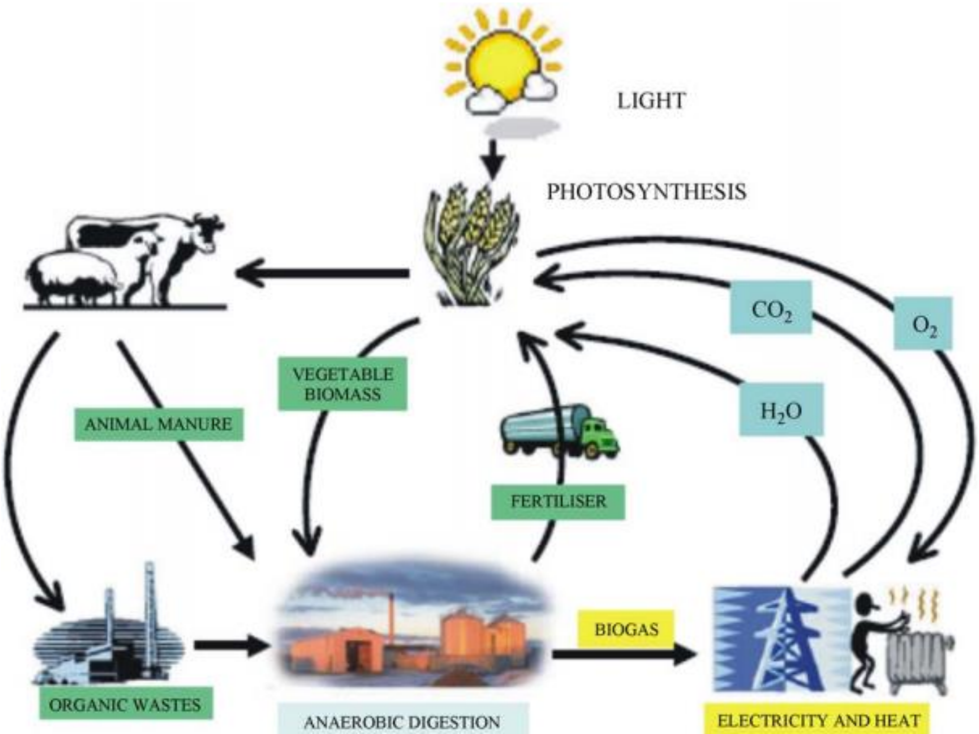

Figure 2. Diagram of the sustainable cycle of anaerobic co-digestion of organic wastes and animal manure.

Biogas has a specific benefit. even in comparison to other renewable energy sources. It may readily be kept and generated as needed. It can be utilised in the same applications as natural gas and can be supplied using the current infrastructure for that fuel [25-26]. The biogas can be delivered on the natural gas grid for end use or used directly as fuel for transportation or home cooking [27].

In isolated areas of the world like Turkey, biogas systems are viewed as viable alternatives to the conventional space heating methods (stoves). When compared to conventional heating systems powered by wood, coal and wood mixture, and dry animal waste, biogas heating systems were determined to be economically viable [28]. Both dual fuel mode and engines that run entirely on biogas make it relatively viable to generate electricity from this fuel (Figure 3). When scrubbed biogas was used in dual fuel engines instead of raw gas, the engine's overall performance improved [29].

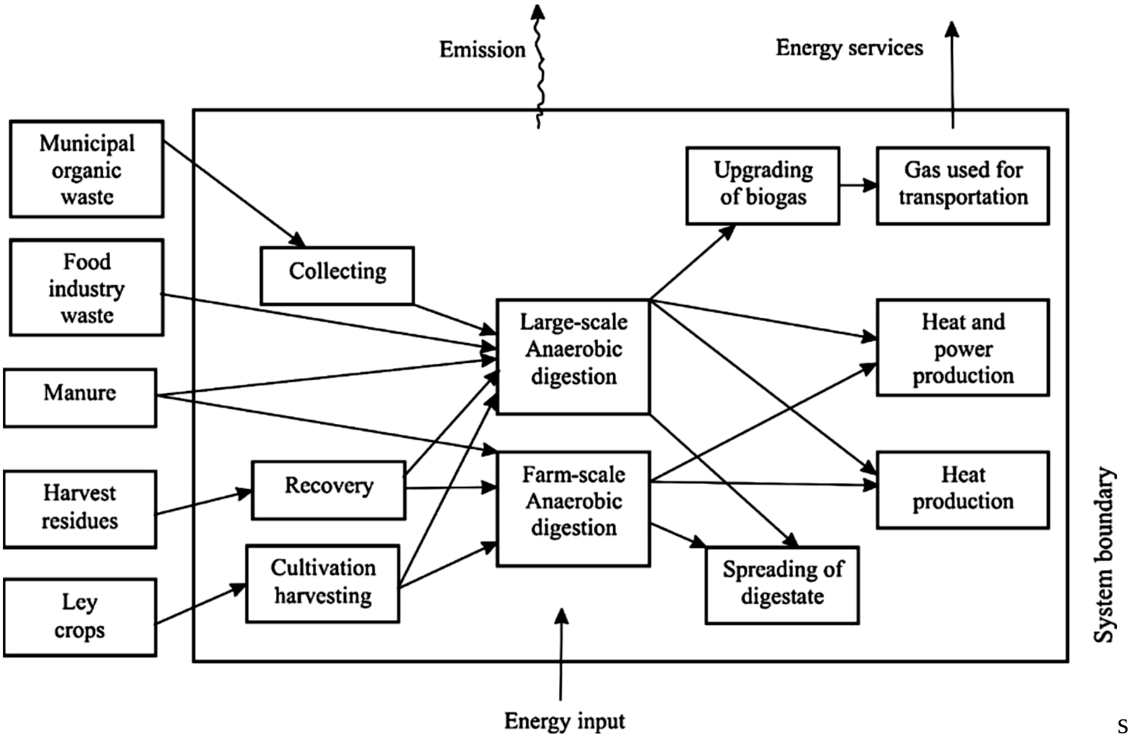

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Figure 3. Overview of the examined biogas systems. The system's material, energy, and emission flows are depicted by arrows.

Biodiesel

A long-chain alkyl (methyl, ethyl, or propyl) esters-based diesel fuel made from vegetable oil or animal fat is known as biodiesel. Typically, lipids (such as vegetable oil, soybean oil, or animal fat (tallow)) are chemically reacted with an alcohol to produce fatty acid esters, which are then used to make biodiesel. Today, it is widely acknowledged that oil is a limitless resource and that its price An exhaustible element is oil. dramatically since its reserves are running out quickly [30]. Clean-burning biodiesel is a sustainable and biodegradable fuel. Mahua oil [31], rubber seed oil [32], Pongamiapinnata oil [33], palm oil [34], Jatropha curcas[35-36], duck tallow [37], and castor seed oil [38] are all used to make biodiesel, and blends of these oils have characteristics regarding performance that are similar to those of diesel [39].

Biodiesel has the possibility of reduce emissions from the transport industry, the potential for largest greenhouse gas producer. Moreover, the usage of biodiesel lowers the amount of particulate matter that is discharged into the atmosphere as a result of burning fuels, potentially improving human health. [40]

According to a study using the Indian context, around 79,782 tons of CO2 emissions can be avoided annually if 10% of the world's castor bean oil production is converted into biodiesel. There is no additional environmental impact because the CO2 emitted during biodiesel burning can be recycled during the production of the following crop [41].

Biomass Gasifier

Through a series of thermo-chemical reactions, the "biomass gasification" process transforms solid biomass fuel into a gaseous combustible gas (sometimes referred to as producer gas). The gas has a calorific value of between 1000 and 1200 kcal/Nm3 (kilocalories per standard cubic metre), making it a low-heating fuel (Figure 4).

Figure 4. Gasifier installed at M/s Phosphate India Pvt. Ltd., Udaipur.

Research on biomass burning and gasification technologies for renewable energy has been conducted by organizations such as the Energy at Resource Institute (TERI) and the Sardar Patel Study on Renewable Energy Institute (SPRERI). More than 350 TERI gasifier systems have been successfully installed in the field across India, with an aggregate capacity of roughly 13MWth [42]. The downdraft gasification-based gasifier technologies that are readily available in India are predominantly made for woody biomass [43]. IISc, Bangalore created a practise set to dry marigold flowers using an open top downdraft gasifier. The designed gasifier is capable of totally replacing 2000 l of diesel or LDO each day. The system runs for more than 4000 hours, practically nonstop, over 140 hours every week, and totally replaces fossil fuel [44]. Pathak et al. [45] developed a modular mouth type upward draft gas generator with a 1.39MW thermal carried capacity.

Improved Cook Stoves

One of the primary sources of energy is scarce, which contributes to a number of issues that people in the developing world experience.. The typical cooking stove's combustion process is imperfect and favours incomplete combustion. Traditional cookstoves' incomplete and inefficient combustion results in large amounts of PIC, which are comprised of fine and ultrafine particles. The global warming potential (GWP) of fine particles is higher than that of CO2 [46].

Household improvements could result in three different types of advantages:

1) Reduced human exposure to health-harming air pollutants;
2) Reduced emission of greenhouse gases that are thought to increase the likelihood of global climate change
3) Reduced fuel consumption, which will benefit households financially, temporally, and improve the sustainability of the natural resource base [47]. A single burner can save roughly 700 kilograms of fuel wood year while also reducing CO2 emissions by 161 kg. It also lessens the strain of fuel collection, which benefits women's and children's health [48].

HYDROGEN AS FUEL

To power automobiles and electric equipment, hydrogen fuel is used in electrochemical cells or by the combustion process in engines that burn gasoline. Furthermore employed in spaceship propulsion, it has the potential to be manufactured in large quantities and marketed for use in passenger cars and aeroplanes. In order to fully utilise biomass resources, create a highly effective, clean method for producing hydrogen on a large scale, and reduce reliance on unstable fossil energy sources, thermochemical conversion processes like pyrolysis and gasification of biomass have significant potential for producing renewable hydrogen [49].

Biomass has the following primary advantages over hydrogen:
1. Since using biomass reduces CO_2 emissions, switching to sustainable biomass fuel instead of fossil fuels is one alternative to consider when lowering CO_2 emissions.
2. The value of agricultural output is increased by the conversion of residues.
3. Due to a lack of available land, disposing of municipal waste is becoming more expensive[50-52].

CONCLUSION

The most significant renewable energy appliances, such as solar water heaters, solar cookers, dryers, wind energy, biogas technology, biomass gasifiers, updated cook stoves, and biodiesel, were evaluated for both domestic and commercial use. The evaluation of renewable technology offers a summary of the evolution and scope of CO_2 mitigation for clean and sustainable development. The most practical and straightforward way to use solar energy is to use a solar cooker. An alternative that can prepare the fruits and vegetables in a clean, sanitary, and hygienic manner is solar drying technology. A mature renewable energy source, wind energy has a great deal of potential to replace traditional sources of energy in the future. When used in place of traditional diesel, biodiesel made from non-edible vegetable oil lowers carbon dioxide emissions and petroleum consumption. Technically speaking, biodiesel is comparable to or superior to traditional petroleum diesel fuel. Biodiesel contains oxygen, which enhances combustion and lowers emissions of hydrocarbons, carbon monoxide, and particulates; oxygenated fuels also tend to produce more nitrogen oxide. If wind potential is present, wind energy has excellent promise for reducing greenhouse gas emissions. The study discusses the possibility for reducing greenhouse gas emissions in relation to the use and accessibility of renewable energy.

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